SUCH WILL BE OUR SHIP

B. Zhadonov, N. Yuzhov

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Abstract

A detailed, but nontechnical description of the Soyuz spaceship which will participate in a cooperative mission with the US Apollo ship in July, 1975 is given. An explanatory diagram of the ship is given, with explanations; and a chronological descriptive table of previous Soyuz, Cosmos, Molniya and Oreol missions in 1973-1974 is offered.

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As is well known, July 1975 is set as the date of the combined experimental flight of the Soviet Soyuz spaceship and the American Apollo ship. Its goal is the testing of combined facilities for approach and docking of space vehicles of various countries, and the development of methods of transfer of cosmonauts from ship to ship. /34

In the experimental flight, the participating Soyuz has a two-seat configuration, equipped with a new androgino-periphery docking unit, UHF radiostations, light beacons, and lamps for detection of and docking with the Apollo.

The Soyuz ship consists of a descent vehicle, orbital and instrument unit compartments, and a docking unit.

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*Numbers in the margin indicate pagination in the foreign text.

The descent vehicle and the orbital compartment are the living compartments of the ship. The temperature of the air in them is maintained within the limits 15-20°C; the humidity within the limits 6-16 mm Hg; and the general pressure during self-contained flight is 660-860 mm Hg at a partial pressure of oxygen of 160-270 mm Hg.

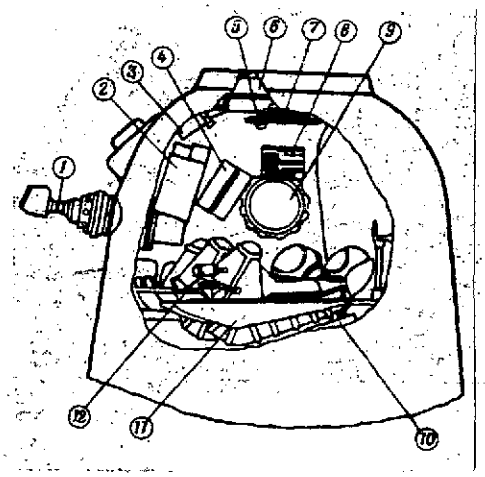
In order to shorten the time for decompression during transfer of cosmonauts from ship to ship, the general pressure in the Soyuz is lowered to 490-500 mm Hg and the partial pressure of oxygen to 140-200 mm Hg. The maximum permissible partial pressure of carbon dioxide is not greater than 10 mm Hg.

The volume of the living compartments of the Soyuz is about 10 m^3. Their atmosphere is cleaned by a regenerative unit in the orbital compartment, which is the basic unit. It is turned on immediately after the spacecraft is placed in orbit. During the phases of descent from orbit and landing, the regenerative unit located in the descent vehicle is used.

When the regenerative unit in the orbital compartment is operating, the air in it from the living compartments of the ship circulates through a distributing valve. Here, by means of a ventilator, it is cleaned and enriched with oxygen. A gas analyzer gives the signals for turning this device on and off. The gas analyzer continuously measures the content of oxygen, carbon dioxide, and water vapor in the ship's atmosphere. The results of these measurements are delivered to the cosmonauts' instrument panel.

The temperature and humidity in the living compartments are maintained within given limits by a heat exchanger condenser which consists of a liquid air radiator with a porous wick located between small tubes for the removal of moisture. Moisture from

the wicks is delivered to the moisture extractor from which it is periodically evacuated by a hand pump. For cooling, the air is driven through the liquid air radiator by a ventilator.



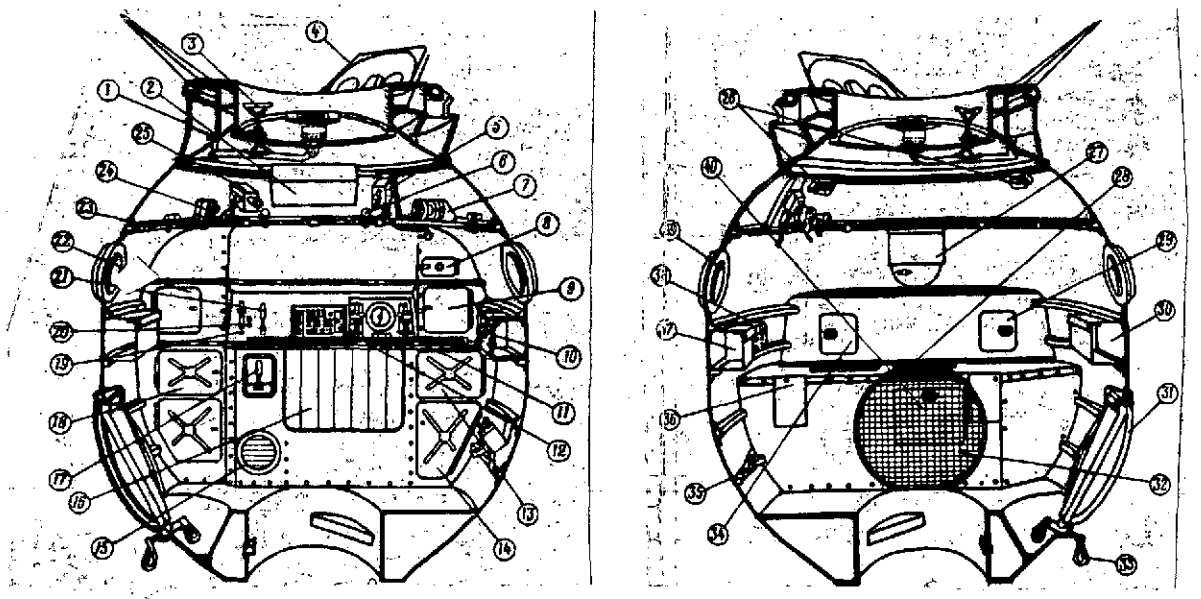
Descent Vehicle

1 - optical viewer-orientator; 2 - instrument panel; 3 - television camera; 4 - command signal unit (CSU); 5 - television light; 6 - air lock cover; 7 - air control wheel of air lock; 8 - control panel for radiostations; 9 - porthole; 10 - instruments and devices; 11 - armchair for cosmonaut; 12 - control handle.

During firing of the Soyuz into orbit, maneuvering in orbit, and descent to earth, the crew is located in chairs in the descent vehicle. The commander of the ship sits in the center chair and the flight engineer sits in the side chair.

The descent vehicle is the basic work area. From here, the crew carries out the majority of operations connected with the control of the ship. The descent vehicle is a hermetic compartment of segmented-conical form. On its outside a heat-protective covering is applied, and its lower part is covered by a heat-protective shield which is jettisoned near the earth. In the

compartment are two side windows for visual observation, taking motion pictures and photographs, and one for the sight orientator.



Orbital Compartment

Left Side

1 - docking unit; 2 - control unit for docking system; 3 - handle to open air lock cover; 4 - control lug of docking unit; 5 - television camera; 6 - television light; 7 - circulation ventilator; 8 - first aid kit; 9 - food rations; 10 - food heater; 11 - control gasket for docking seal; 12 - panel for the orbital compartment; 13 - facilities for personal hygiene; 14 - sleeping bags; 15 - grate of opening exit of air from heat exchange condenser; 16 folding table; 17 - hand pump for evacuating condenser products; 18 - lock for entrance to the sewage sanitary unit (SSU); 19 - drinking fountain; 20 - fuse circuit; 21 - hand pump for water supply system; 22 - lock for access to the SSU; 23 - handrail; 24 - movie camera; 25 - Apollo television camera.

Right Side

26 - light for working illumination; 27 - gas analyzer; 28 - restraint belt; 29 - storage for spacesuit hoses; 30 - waste container; 31 - embarkation lock cover; 32 - protective grating; 33 - handle for shutting lock cover; 34 - storage of bushing of the SSU; 35 - bracket for the Apollo television camera; 36 - folding seat; 37 - container for carrying equipment; 38 - distribution box; 39 - porthole; 40 - storage for spacesuits.

The internal volume of the descent vehicle is conditionally divided into two functional zones, a work and an instrumentation zone. In the work zone are: armchairs for the crew, hand instruments for control of the ship's systems, equipment for display and presentation of information, an air lock, and a container for the housing of scientific apparatus. In the instrument zone are: machinery and equipment for the life support systems, automatic control systems for descent, instruments for the landing system, apparatus for radio communication, and other equipment.

On the armchair there are control handles for the movement of the ship, and immediately in front of the cosmonauts is an instrument panel with command-signal equipment.

The basic instruments are located on the instrument panel. We will name the most important of these.

The space navigational indicator is the electromechanical program unit reproducing the movement of the earth. It emits information on the present position of the ship on the globe or by scales for a report of longitude and latitude, on the hypothetical place of landing of the ship (if at a given moment the order to land is given), on the place above which the ship is located at a given moment, and on the time remaining until entrance into the shadow of the earth or exit from it. With its help, the cosmonauts know the control points with which radio communication is possible.

The electroluminescent indicator, an instrument for light and sound signalling, is intended for giving advisory and emergency warning information on the condition of flight systems. Advisory information is given with the aid of transparencies of blue-green color; warning information, with a yellow color and an audio signal; and an emergency is indicated by red transparencies and a two-tone audio signal.

The combined electronic indicator allows the cosmonauts to carry out docking by television control, to make a survey of living compartments and surrounding space, and to control analogous parameters of a series of flight systems.

The program control indicator makes it possible, according to the light indices, to control visually the automatic control programs, the pre-set time of various parameters to be controlled sequentially, and the time of execution of commands.

With the aid of a digital indicator unit, data is manually introduced for the operation of the orientation system, and the supply of fuel for the main engine unit is controlled. Using this instrument, the cosmonauts determine the size of an impulse of speed increment during maneuvers.

The indicator of voltage and current makes possible control of the operation of one power supply system.

Furthermore, indicators are placed on the instrument panel, for control of: pressure in the gas cylinders of the system of pressurization of the living compartments, the system of supply for the gas mixture, the volume regulator for the radiocommunication channels, the regulation of lighting intensity, and of the key of an output device for especially important and official control commands.

During manual control of the ship, commands are given with command signal devices (CSU), which also allow the control of transmission of commands. These devices are placed to the left and right of the instrument panel and are corresponding named CSU-L and CSU-P. The CSU's are identical in construction. On them are keys for the output of commands, light transparencies for signalling, regulators of volume of the radiocommunication

channels, and the transmitter cut-off switch for the radio transmitter. Control of the ship's systems is possible both simultaneously with both CSU's or with the left or right CSU alone.

The inside surface of the descent vehicle is covered with a heat-insulating and soft decorative material.

The Soyuz ship is operated with the help of a system of orientation and control of motion. The system can operate in the automatic state and in the manual control state. Included in it are: thermionic transmitters for acceleration and braking, installed, correspondingly, in the orbital and instrument unit compartments; a sensing unit for the infrared vertical line and a sensing unit for solar orientation, installed in the instrument unit compartment; a viewer-orientator; gyroscopic instruments and electronic computing units; radio apparatus providing for approach; and a system of executive instruments consisting of motors of small thrust with independent fuel supply systems.

The system of small thrust motors is composed of 14 berthing and orientation motors with a thrust of 10 kg each. They are used for turning the ship relative to its center of mass and for shifting its center of mass. For fine orientation the ship is equipped with 8 orientation motors with a thrust of 1 kg each.

All the small thrust motors are located on the instrument unit compartment.

During manual control of the ship, the cosmonauts use handles mounted on the armchair. The right control handle serves for orientation of the ship along three axes: pitch, yaw, and roll. Using the left handle, the cosmonauts control the shift of the center of mass of the ship.

Television transmission from the descent vehicle is transmitted to earth by a television camera with an objective lens having a field of view of 75°; the camera is located above the instrument panel. During transmission, television transmission lights are turned on, in addition to working illumination.

The cosmonauts use the orbital compartment for conducting scientific experiments, physical exercise, and rest. It also serves for the transfer of crew members from ship to ship after docking.

In its construction, the orbital compartment consists of two half-spheres joined by a cylindrical insert. Here, there are two scanning portholes and a side entrance lock used for the embarkation of the crew onto the ship on the starting platform.

The internal surface of the orbital compartment is covered with a soft decorative material. Outside the compartment, handrails are installed to facilitate the cosmonauts' travel.

The members of the crew rest on a couch located on the right side of the compartment (from the entrance lock). At rest time the cosmonauts are held by special belts.

Inside the couch are located transmitters of the UHF radiostation, a unit for regeneration and cleaning of the atmosphere, and individual instruments of the system for orientation and control of motion.

On the Soyuz ship there will be transceivers and a carrier for the range frequencies of the Apollo radiostation which permit the Apollo ship to receive data on the changes of distance between the ships, necessary for a calculation of approach maneuvers.

the Apollo radiostation, with a separate power supply, switching circuit for the docking system, tank with drinking water (for 30 liters), container of food, flight first aid kit, facilities for personal hygiene, and sleeping bags, are placed on the left side of the compartment, in the "servant."

For eating food and carrying out a series of scientific experiments, a folding table, which is riveted to the forward wall of the "servant," is used. Above the "servant" is a control unit for the docking system.

In the orbital compartment are a television camera, a motion picture camera, lamps for work and television illumination, a unit for heating food, and containers for carrying equipment.

On the upper frame of the compartment is mounted an androgino-peripheral docking unit.

At the time of docking, the cosmonauts are seated in arm-chairs in the descent vehicle. Observation is carried out through the side portholes, and the viewer-orientator, with the help of an external television camera mounted on the orbital compartment. The optical axis of the television camera corresponds to the longitudinal axis of the ship. The television camera has two fields of view: narrow and wide.

On the outside of the orbital compartment, a docking "target" is mounted which provides the Apollo crew with information on the angle of mutual roll, pitch, and yaw.

The Soyuz ship is equipped with two strobe beacons for its optical tracking from the Apollo ship and with flight orientation lamps on solar battery panels (red on the left, green on the right, and two white lamps) which allow the Apollo crew to

estimate mutual location of the ships in the process of docking. The crew carries out the final alignment of the ships during docking in the manual control state, using the docking target mounted on the Soyuz and the sighting unit mounted on the Apollo ship.

After docking the astronauts cross into the Soyuz ship, bringing with them a television camera for transmission of pictures to earth; they mount it on the bracket in the orbital compartment, and attach it to a special switch box. The Apollo radio communication equipment is also attached to this switch box.

Underneath the descent vehicle is mounted an instrument unit compartment used to arrange the main flight equipment of the ship and its motor unit.

In its construction this compartment consists of three sections: a connecting section, an instrument section, and an accessory section.

In the connecting section are fuel tanks and balloon gas tanks for pressurization of the executive unit system and the major portion of the docking and orientation motors. On the outside of the connecting section is a small radiator, a radiating element for the system of thermal regulation, and a multi-dipole antenna for the master microwave link.

The instrument section is hermetically constructed. In it are the main instruments and devices for the ship when operating in orbital flight.

The accessory section is designed for arrangement of the approach-correction motor unit, electric power supply circuits, and motors for docking and orientation.

On the outside of the accessory section are a large radiator-emitter for the thermal regulation system, the UHF communication antenna, and the radiotelemetry system antenna.

On the instrument accessory compartment are mounted panels of solar batteries consisting of three panels each, with a usable surface of about 10 m^2. On the end panel are antennas for the HF and UHF links, an antenna of the radiotelemetry system, and colored side-running lights for orientation.

The approach correction motor unit (the main motor unit) provides increments of speed along the longitudinal axis of the ship during corrections in orbit, and braking for descent. It is composed of a main approach-correction single-chamber motor of 417 kg thrust; a duplicate two-chamber motor with a 411 kg thrust; and fuel tanks with a system of fuel supply and automatic control.

During the operation of the main and duplicate motors the ship is stabilized on all axes (during the operation of the basic motor, with the help of docking and orientation motors; during the operation of the duplicate motor, with the help of steering nozzles).

For the return of the crew in a specified landing region, the ship is automatically or manually orientated in space and the main motor unit is turned on for braking. During the time of its operation the speed is reduced and the ship begins its movement toward earth. At the calculated time of descent, according to a command from the program-time unit, the descent vehicle separates from the orbital and instrument unit compartment. The system of descent control is then turned on. The executive elements of that system, consisting of six motors, are located on the body of the descent vehicle. They hold the descent vehicle in a position which allows it to use its aerodynamic quality. This makes it

possible to reduce by 3-4 times the deceleration factor the crew is subjected to during descent in the atmosphere.

The parachute system is automatically put into operation for completion of braking in the atmosphere.

After release of the front heat protective screen and the descent by parachute immediately before landing, the solid fuel braking motors for soft landing, which are located on the base of the descent vehicle, are turned on.

Launch Date day/month/year	Name of Vehicle	Initial Period of Revolution in minutes	Apogee, km	Perigee, km	Declination of Orbit in Degrees
31/10/73	Cosmos-605	90.7	424	221	62.8
2/11/73	Cosmos-606	710	39,360	626	62.8
10/11/73	Cosmos-607	90	364	214	72.9
14/11/73	Molniya-1	11 h 42 m	39,140 in the northern hemisphere	480 in the southern hemisphere	65
20/11/73	Cosmos-608	92.3	528	281	71
21/11/73	Cosmos-609	90	307	207	70
27/11/73	Cosmos-610	95.2	560	515	74
28/11/73	Cosmos-611	92	507	280	71
28/11/73	Cosmos-612	90.1	371	214	72.9
30/11/73	Cosmos-613	89.1	295	195	51.6
30/11/73	Molniya-1	12 h 17 m	40,900 in the northern hemisphere	460 in the southern hemisphere	62.7
4/12/73	Cosmos-614	100.7	830	770	74
13/12/73	Cosmos-615	95.7	859	280	71
17/12/73	Cosmos-616	89.9	355	214	72.9

Launch Date day/month/year	Name of Vehicle	Initial Period of Revolution in minutes	Apogee, km	Perigee, km	Declination of Orbit in Degrees
18/12/73	Soyuz-13				
19/12/73	Cosmos-617-Cosmos-624	114.8	1,511	1,404	74
21/12/73	Cosmos-625	89.8	346	214	72.8
25/12/73	Molniya-2	12 h 17 m	40,865 in the northern hemisphere	466 in the southern hemisphere	62.8
26/12/73	Oreol-2	109.2	1,995	407	74
27/12/73	Cosmos-626	89.7	280	257	65
29/12/73	Cosmos-627	105	1,032	991	83
17/1/74	Cosmos-628	105	1,026	975	83
24/1/74	Cosmos-629	89.4	315	202	62.8
30/1/74	Cosmos-630	90	367	213	72.9
6/2/74	Cosmos-631	95.3	565	522	74
12/2/74	Cosmos-632	89.4	333	184	65

Purpose of Vehicle

Soyuz-13 is a spaceship. It was piloted by a crew composed of ship commander Pyotr Il'yich Klimuk and flight engineer Valentin Vital'yevich Lebedev.

In the course of an eight-day orbital flight with the aid of an Orion-2 telescope system, spectrograms were obtained for stars in various constellations in the ultraviolet region; spectrographing was done; and multi-zone photography of parts of the earth's surface was done; with the use of a Levkoy device characteristics of blood circulation in the brain in various stages of adaptation were studied; with the help of an Oasis-2 system possibilities for obtaining proteinaceous biomass were studied, improvements were worked out in instruments and methods of orientation, providing high precision in directing the telescopes.

The flight of the Soyuz-13 spaceship took place on December 26, 1973.

The sputniks Cosmos-617 and Cosmos-624 were placed in orbit by one rocket booster.

Purpose of Vehicle

Oreol-2 is a satellite. It is intended for the continuation of research on physical phenomena in the upper atmosphere of the earth at high latitudes and study of the nature of polar aurorae begun with the Oreol satellite in 1971. The satellite was put in orbit in accordance with a program of USSR-French cooperation in the field of investigation and exploitation of cosmic space for peaceful purposes.